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(54) A METHOD AND APPARATUS FOR CARRYING OUT CONTINUOUS CHROME-PLATING OF THE EXTERNAL SURFACE OF BARS OR TUBES

(71) I, SERGIO ANGELINI, an Italian citizen, of Via M.F. Quintiliano, 15, Milan, Italy, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of carrying out continuous thick chrome plating of the external surface of bar, and tube, and apparatus for implementing said method.

Hitherto, methods of carrying out thick chrome plating of the external surface of bar, and tube, have been executed by immersing the individual items to be chrome-plated in various baths or vessels, and at the best these processes have used no more than rudimentary degrees of automation.

The object of the present invention is a method which makes possible the continuous chrome-plating of the external surface of bar and tube. In particular, this method makes it possible to increase the production rate and therefore as a direct result of this, to reduce the production cost. Another major advantage of the method of the invention resides in the uniformity of deposition of the chrome layer on the components being plated, thanks to the uniformity of relative movement between the component in question and the anode, the whole being immersed in the chromic acid solution and moving at the same time.

Traditional chrome plating, carried out by immersion only, always gives rise to irregularities in the thickness of the chrome plate, due to the varying values of electrical resistance presented by the anode over its total length, especially when chrome plating components which are elongated. Attempts to overcome this drawback of the traditional systems have been made by connecting the anode at more points to the d.c. source, the anode being appropriately shaped, and by adopting other artifices of a kind suggested by practical experience.

According to the present invention a method of carrying out continuous chrome-plating of the external surfaces of bars and tubes includes feeding a continuous series of bars or tubes at a predetermined rate, in order to establish the time of plating and therefore the thickness of the chrome deposit, into a chromic acid solution contained in a chrome-plating vessel, said vessel containing an anode, the bars or tubes being connected together to form a continuous length and serving as the cathode, and continuously moving the anode and cathode relatively to each other. The continuous length of bars or tubes for chrome-plating can be rotated around its own longitudinal axis in order to contrive more uniform distribution of the chrome over the surface and also to prevent any hydrogen bubbles, which may develop during the process, from being trapped on the lower part of the bars or tubes being plated with consequent irregularities in plating. Using this process, bars or tubes can be chrome-plated with a constant chrome thickness it being possible to establish right from the start the thickness which is required as this is a function of the current, the bath temperature and, more especially the time of immersion of the component in the bath, the latter factor being linked directly with the rate of transfer of the bars or tubes being plated.

Moreover, the continuous method of the invention includes automation and single flow line production, this extending equally to the other operations required such as preparing the component for chrome-plating and finishing off the plated product.

Conveniently therefore the method can include passing the bars or tubes to be plated through a complete production line by subjecting them in succession initially to preparatory operations including emerying and roughening, then to chrome-plating proper, followed finally by drying and polishing.

Preferably the anode for carrying out the chrome plating and/or the cathode element for electrolytic etching has an annular form

and the bars or tubes are passed through it, and it is also provided with perforations to enable gasses developed during the operation to escape.

Obviously, the cathode is constituted by the component being chrome-plated, this being electrically connected to the negative terminal of a d.c. power source, whilst the anode is connected to the positive terminal of said same source. During the passage of the bars or tubes past the adjacent surface of the anode, chrome is deposited upon its surface, the chrome-plating vessel being completely full of chromic acid plating solution, the anode being immersed in the solution and thus, too, the component being chrome-plated, which acts as cathode. On exit from the chrome-plating vessel, still in a continuous operation, a final washing operation is carried out on the component in order to remove any residue of chromic acid, this being followed by drying and, finally, by polishing with brushes, preferably rotating ones in order to give the component the desired finish and enable it to be marketed without need for any further operations.

The invention also includes apparatus for carrying out the continuous method and this comprises a chrome-plating vessel containing an anode, means for joining a number of bars or tubes together to form a continuous length, means for causing the bars or tubes in the vessel to act as a cathode, and means for continuously feeding the interconnected bars or tubes into the vessel.

The invention may be performed in many ways but one method and apparatus for carrying it out will now be described by way of example and with reference to the accompanying drawings in which:—

Figure 1 is a lateral elevation of all the machine components involved in a production line for the continuous chrome-plating of bar and the external surface of tube according to the invention.

Figure 2 is a front elevation of the emerying machine which forms part of the production line set out in Figure 1,

Figure 3 is a side view of a sand blasting machine for roughening the surface and which can form part of the production line of Figure 1,

Figure 4 is a side view of an electrolytic etching machine for roughening the surface of the component and which can form part of the production line of Figure 1,

Figure 5 illustrates an insulating coupling for connecting two bar sections together, this also forming part of the production line of Figure 1,

Figure 6 is a partially sectional frontal view of a machine for washing the chrome-plated bars, said machine forming part of the production line of Figure 1,

Figure 7 is a sectional lateral view of the machine in Figure 6 which forms part of the production line of Figure 1,

Figure 8 is a longitudinal section through a two-way gland,

Figure 9 illustrates a longitudinal section through a variant embodiment of the gland shown in Figure 8, and

Figure 10 is a frontal view of the machine marked 25 in Figure 1, for carrying out roughening by chemical etching.

The continuous chrome-plating production line apparatus for interconnected sections of bar and tube, in accordance with the invention (Figure 1), is made up of a number of separate operating stations or units which are responsible for the various operations required in order to effect continuous chrome-plating of a bar 16 namely:

(a) an emery unit 11 designed to prepare the surface of the bar 16 being chrome-plated, Figure 2 illustrating a section thereof. This emery unit comprises a twin metal frame 12 carrying three shafts 13 each with two series of pulleys 14 and 14^1 located radially around a central hole 15 through which the bar 16 being processed passes. The three pulleys 14^1 out of the downstream part are also arranged, as an inspection of Figure 1 will show, in three mutually parallel planes. Around these pulleys and the bar 16 being processed, emery belts 17 with the emery surface facing inwards, are arranged. Each belt 17 lapping an arc of circumference of the bar 16 of more than 120° so that the bar is completely embraced by circulating emery faces. The three shafts 13, being equipped with two ball-bearings assembled on the twin frame 12 and slidable and lockable in relation thereto, are fitted in the upstream direction with three pulleys 14^1 connected to a transmission belt driven by an electric motor 18. The speed of operation is determined in accordance with the metal being processed.

(b) a drive unit 21 which produces the bar feed, is constituted by a body slidable on vertical guides 22 and comprises: an electric motor, a continuously variable step-down gearing arrangement, a soft rubber roller 23 which grips the bar 16 which is being fed. The unit thus formed is provided with a counter-weight 24 which facilitates vertical displacement, and the bar 16 is supported by rollers 23*a* carried on a support table 23*b*. The rubber roller 23, if arranged so that its axis is not at right-angles to the axis of the bar 16, will not only produce forward feed of the bar but also simultaneous rotation therein, about its own axis.

(c) a unit 25 designed to facilitate chrome-plating of the surface of the bar 16 by superficial roughening in the form of chemical etching or by sand-blasting or by electrolytic etching. A unit for carrying out roughening by chemical etching, is shown

in side elevation in Figure 1 and marked 25, being constituted by an etching chamber 31 with a horizontal axis and made of plastic material, the chamber having a cylindrical form and being connected at the top to a hopper 32 containing acid for the process. The end walls 33 of the chamber 31 are perforated at the centre to pass the bar 16 being processed and are fitted with special packing glands or seals 34 which prevent the acid from escaping. A top cover 35 with an exhauster 36 is provided to draw off the fumes.

An alternative roughening unit which employs sand-blasting is indicated by way of example in Figure 3 and comprises a sand-blasting chamber 26 in the form of a horizontal axis tube lined internally with plastics material in order to resist the effect of the sand-blasting operation. Through this chamber 26, the bar 16 being processed, passes longitudinally. The ends of the sand-blasting chamber are closed by glands perforated centrally at 27 and fitted with seals to prevent the escape of sand during the transfer of the bar 16 which is to chrome-plated. A conventional sand-blaster 28, connected to the nozzles 29 located inside the sand-blasting chamber 26, completes the apparatus which is connected to a sand exhauster 30.

In Figure 4, an electrolytic etching unit 37 for producing surface roughening or a surface key, which can be substituted for the unit 25, is constituted by a tube 38^1 with a horizontal axis and an upper hopper 37^1 through which the bar 16 being processed passes. The terminal parts of the tube 38^1 are externally threaded in order to receive gland plugs 38 equipped with special packings to be described hereinafter. Inside said tube 38^1 there is installed a ring-cathode 39 with a perforated surface, of appropriate diameter. The perforation of the walls of the cathode is necessary in order to promote the escape of the gases which are developed during electrolytic etching. The cathode 39 will, as circumstances dictate, be made of a lead-antimony-silver alloy or for that matter of platinum-plated titanium. The bar 16 serves as anode, passing inside the cathode 39 so that its surface is subjected to a greater or lesser degree of electrolytic etching, depending upon the rate of feed. The current through the anode, that is the bar 16, is transmitted through appropriate rotating and sliding brushes or jaws 40, which can be designed to accord with the bar section. On the top part of the hopper there is installed a cover 41 with an exhauster 42 for removing the fumes. The whole apparatus is carried by a profiled metal frame 43 whose height is such as to bring it into alignment with the other units forming part of the production line through which the bar 16 is continuously fed. Below there is a reservoir 44 containing the liquid used for the electrolytic etching, said reservoir being equipped with a pump 45 for the continuous circulation of said liquid. The temperature of the liquid used for chemical etching, will be established as the case requires, in accordance with the diameter of the product being chrome-plated, means (not shown) being provided for automatically controlling this temperature.

Another unit which is part of the production line is marked 46 in Figure 1, this unit being the actual chrome-plating unit and comprising a chamber 47 of tubular form with its axis horizontally disposed, connected at the top part to the hopper 48 which is responsible for chanelling the gases developed during the process, towards the cover 49 located above, with its exhauster 50, and for holding the liquid required by the chrome-plating operation. The extremities of this chrome-plating chamber 47 which thus provides a chrome-plating vessel are provided with threaded portions for the attachment of gland plugs 38 through which the bar 18 for chrome-plating and which are similar to the gland plugs used in the electrolytic etching unit 37. The device is equipped with a reservoir 54 for the chromic acid, the reservoir being equipped with a pump 55 of non-corrosible material which is immersed in said reservoir and maintains the liquid level required for chrome-plating in the chamber 47, the latter also being equipped with a device 56 for automatically monitoring the temperature of the liquid during the operation. Inside the chrome-plating chamber 47 an anode 57 is located, similar to the cathode 39 of Figure 4 herein before described but of a different length, the length being designed as a function of the time for which the bar 16 remains in the chamber. The length of the chamber 47 in which chrome-plating takes place, is designed to accord with the rate of feed of the bar 16 and the desired thickness of chrome-plate. The direct current required is supplied by rotary generators or static transformers.

It is important to bear in mind that between the unit 37 (Figure 4) for carrying out electrolytic etching, when this kind of process is employed, and the continuous chrome-plating unit 46 (Figure 1), it is necessary to reverse the polarity of the bar; for this reason, a suitable device is arranged between the two units 37 and 46 which are spaced at a suitable interval from one another. The continuous length of bar 16 is made of a series of bar sections connected to one another by couplings 58 (Figure 5), these latter electrically insulating each bar section from its neighbour and thus enabling the polarity to be reversed. On exit

from the chrome-plating chamber 47, the bar 16 is washed by the device shown in Figures 6 and 7, this constituting a cylindrical washing chamber 59 the glands of which are axially aligned in order to pass the bar 16 for washing. Inside the washing chamber a series of nozzles or jets 60 are provided through which high-pressure water jets are sprayed, the water coming from a ring main 60^1.

A following unit then carries out drying. This device is substantially the same as that described hereinbefore for the washing operation, with the difference that the nozzles produce hot air.

The production line is then completed by a machine 11^1 which is identical to that 11 shown at the head of the line 1, which is equipped with emery belts of the desired grade in order to finish off and polish the processed bar.

The production line then terminates in a standard wrapping machine, not shown in Figure 1, which wraps the bar in a continuous protective band.

The continuity of working is a feature of particular interest and is obtained by coupling separate bar sections together using insulating couplings of the kind marked 58 (Figure 5). Couplings or joints of this kind are made of insulating material and take the form of a cylinder 58^1 of appropriate length and having the same section as the bars 16 being coupled, the two ends of the coupling being provided with screw-threads of smaller section 61, which are screwed into tapped holes in the ends of said bar sections 16.

In Figures 8 and 9, sealing rings of the lip tyre or wire glands, have been shown, which are fitted to the ends of the roughening chamber (electrolytic etching) provided by tube 38^1 in Figure 4, and to the ends of the chrome-plating chamber proper, 47, shown in Figure 1.

These glands can be of two types. The first type (Figure 8) takes the form of a first part 38 which is screwed in sealed fashion onto the tube 38^1. This cylindrical part has two internal undercuts 62 in which there are lodged two sealing rings 53 of plastic material. Outside said first part a second part is also screwed on, namely the second gland section 51, which, in internal undercut 63, contains two sealing rings 53 like the ones just referred to. The bar 16 being chrome-plated, passes through the two pairs of seals 53.

Between the two glands a cavity 52 is formed which collects any acid which the bar 16 may carry pass the seals 53, this acid being collected and recirculated, or alternatively eliminated through the pipe 64.

The second kind of gland, shown in Figure 9, is constituted by a screwed plug 65 with an annular spigot 66 around the central orifice, and a peripheral spigot 66^1, the two spigots determining between them an annular channel 66^{11} into which there penetrates the spigot end 68^1 of the tube 38^1, thus creating a seat 68 in which there is assembled and trapped, an annular seal 67 of plastic material. When the gland plug 65 is screwed onto the end 68^1 of the tube, the spigot surrounding the internal orifice compresses the plastic seal 67 causing it to fit snugly up against the bar 16 passing through it.

WHAT I CLAIM IS:—

1. A method of carrying out continuous chrome-plating of the external surface of bars and tubes which includes feeding a continuous series of bars or tubes at a predetermined rate, in order to establish the time of plating and therefore the thickness of the chrome deposit, into a chromic acid solution contained in a chrome-plating vessel, said vessel containing an anode, the bars or tubes being connected together to form a continuous length and serving as the cathode, and continuously moving the anode and cathode relatively to each other.

2. A method as claimed in claim 1 which includes rotating the bars or tubes to be plated about their longitudinal axis as they pass through the vessel.

3. A method as claimed in claim 1 or claim 2 which includes roughening the surface of the bars or tubes prior to passing through the chrome-plating vessel by chemical etching, sand-blasting or electrolytic etching.

4. A method of chrome-plating as claimed in claim 3 which includes preparing the surface for chrome-plating by electrolytic etching which is carried out by passing the bars or tubes to be plated through a cathode element whilst the bar or tube acts as the anode, and moving the anode and cathode relatively to each other.

5. A method as claimed in any one of the preceding claims in which the anode for carrying out the chrome plating and/or the cathode element for electrolytic etching has or have an annular form and the bars or tubes are passed through it, and it is also provided with perforations to enable gases developed during the operation to escape.

6. A method as claimed in any one of claims 1 to 5 which includes passing the bars or tubes to be plated through a complete production line by subjecting them in succession initially to preparatory operations including emerying and roughening, then to chrome-plating proper, followed finally by drying and polishing.

7. Apparatus for carrying out the continuous method claimed in claim 1 comprising a chrome-plating vessel containing

an anode, means for joining a number of bars or tubes together to form a continuous length, means for causing the bars or tubes in the vessel to act as a cathode, and means for continuously feeding the interconnected bars or tubes into the vessel.

8. Apparatus as claimed in claim 7 in which the bars or tubes pass through the anode which is in annular form and is provided with perforations to enable gases developed during the operation to escape.

9. Apparatus as claimed in claim 8 in which the length of the annular anode is determined by the desired thickness of chrome to be deposited on the bars or tubes passing through at a uniform rate.

10. Apparatus as claimed in claims 7, 8 or 9 in which the bars or tubes enter and leave the chrome plating vessel through seals or glands which are below the level of the solution in the chamber.

11. Apparatus as claimed in claim 10 in which the glands for the entry and exit of the bars or tubes are equipped with a screwed plug having a spigot designed to compress a ring seal of plastic material located in a seating in the wall of the vessel, so that when the plug is screwed onto the end of said vessel, the spigot around the internal orifice compresses said sealing ring causing it to fit up snugly around the bars or tubes being processed.

12. Apparatus as claimed in any one of claims 7 to 11 including means for superficially roughening the surface to be plated of the bars or tubes prior to passing through the plating vessel by chemical etching or sand blasting or electrolytic etching.

13. Apparatus as claimed in claim 12 in which the means for carrying out continuous roughening operates by the electrolytic etching technique and comprises a processing chamber of cylindrical form, and a hopper arranged above the chamber containing the liquid for the electrolytic etching operation, said hopper also being designed to channel off the gases which develop in the process of eaching to an upper cowl with an exhauster, the ends of the cylindrical chamber carrying screw threads in order to receive gland plugs with seals or stuffing glands, said chamber being equipped with a device for automatically controlling the temperature of the liquid employed for the roughening operation, an annular cathode immersed in the liquid through which the bars or tubes for chrome-plating pass and said annular cathode being provided with openings for the escape of the gas generated during operation, a supply of electrical power to the anode being effected through connections designed to accord with the tube or bar sections being plated, whilst control of the degree of eaching for roughening purposes is achieved by varying the parameters which determine the operation of the chamber itself.

14. Apparatus as claimed in claim 13 in which the construction of the glands in the walls of the processing chamber are similar to those set forth in claim 11.

15. Apparatus as claimed in claim 12 in which the means for the continuous roughening operation operates by chemical etching and comprises a hopper tube with screwed ends to which gland plugs are fitted, and is provided at the top with a cowl with exhausters for drawing off the fumes, the hopper being full of acid, the level being maintained by a continuous supply system.

16. Apparatus as claimed in claim 12 in which the means for carrying out the continuous roughening operation operates by sand-blasting, and comprises a cylindrical sand-blasting chamber lined internally with an abrasion resistant material said chamber containing a set of nozzles from which the sand is sprayed under pressure, the chamber being connected directly to a sand exhauster and to a full sand-blaster which supplies said nozzles.

17. Apparatus as claimed in any one of claims 7—16 incorporated in a production line which comprises means for continuously feeding the interconnected bars or tubes to be chrome-plated, means for continuously emerying said bars or tubes, means for continuously roughening said bars or tubes, means for continuous chrome-plating, means for continuously washing said bars or tubes after chrome-plating by means of high pressure liquid jets, means for continuous drying using high-pressure hot air or gas and means for continuously polishing and finishing said bars or tubes.

18. Apparatus as claimed in claim 17 in which means for carrying out the emerying of the bars or tubes to be treated is a continuous emery belt system, in which emery belts with the emery surface facing inwards, lap an arc of the outer circumference of the bars or tubes being polished of more than 120° so that the bars or tubes are completely embraced by circulating emery surfaces, the forward movement of the bars or tubes resulting in the emerying of the whole length of the surface being processed.

19. Apparatus as claimed in claim 17 or 18 in which the means for carrying out the continuous feeding of the bars or tubes being processed comprises a support table over which the interconnected bars or tubes are fed, there being arranged at the head of the table a motor-driven traction unit which operates means for advancing the bars or tubes, said means taking the form of a soft rubber roller which rotates and feeds the bars or tubes forward by virtue of the contact pressure.

20. Apparatus as claimed in claim 19 in

which the roller is equipped with a device which allows it to rotate in a horizontal plane so that its axis is disposed transversely of the axis of the bars or tubes with the result that the coupling between the bars or tubes and the roller produces not only forward movement of bars or tubes but also rotation about their own longitudinal axis.

21. Apparatus as claimed in any one of claims 17 to 20 in which the means for the continuous washing of the bars or tubes being processed, using high-pressure liquid jets, comprises a cylindrical washing chamber having axially aligned glands to allow passage of the interconnected bars or tubes being processed, and the chamber being provided internally with a set of nozzles through which the requisite liquid is sprayed.

22. Apparatus as claimed in any one of claims 17—21 in which the means for the continuous drying of the processed components is constituted by a machine similar to that set forth in claim 21 but the nozzle injecting hot air or gas not liquid.

23. Apparatus as claimed in any one of the preceding claims 17—22 in which the bars or tubes are fed through the apparatus continuously, each section being attached to another to form a continuous length by an insulating coupling in the form of a cylinder which has the same section as the bar or tube, said coupling having screwed spigots of smaller section at each end which are screwed into tapped holes in the bar or tube sections which are to be connected.

24. A method of carrying out continuous chrome-plating as claimed in claim 1 and substantially as described herein with reference to and as shown in the accompanying drawings.

25. Apparatus for carrying out continuous chrome-plating as claimed in claim 7 and substantially as described herein with reference to and as shown in the accompanying drawings.

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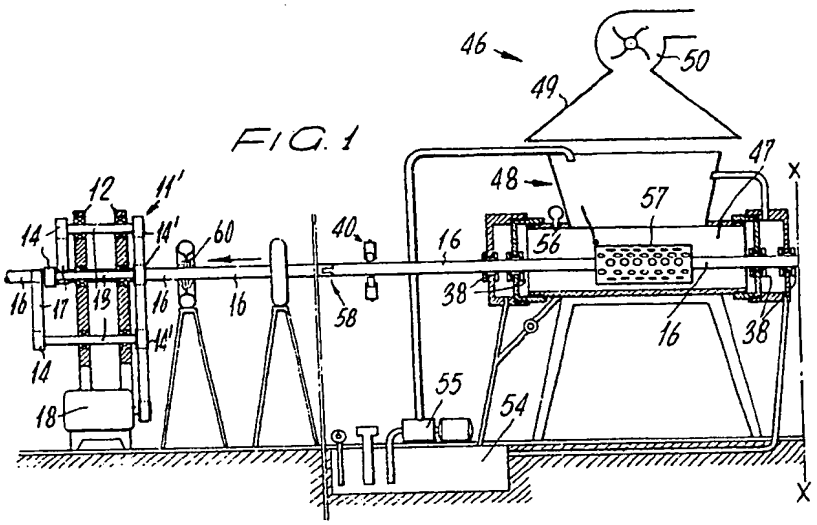

FIG. 1

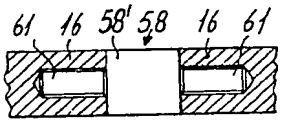

FIG. 5

FIG. 1

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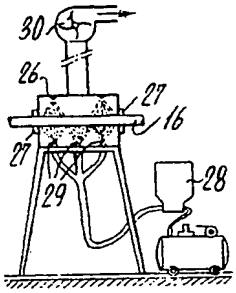

FIG. 3

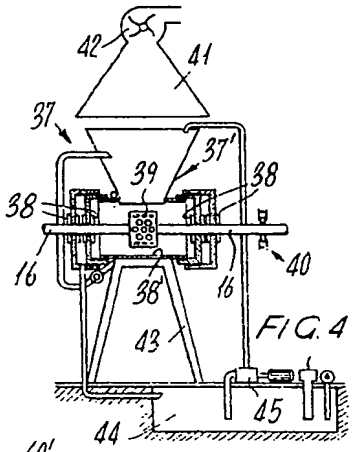

FIG. 4

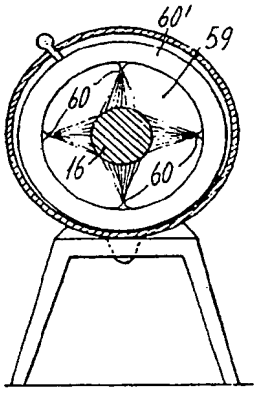

FIG. 6

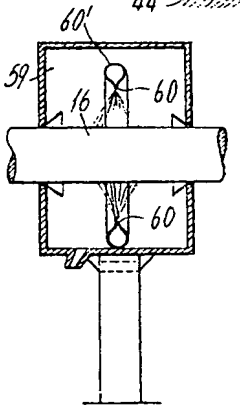

FIG. 7

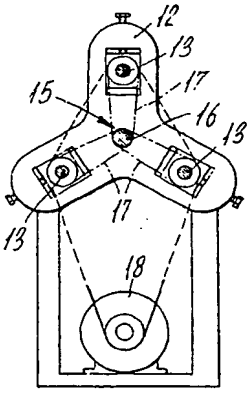

FIG. 2

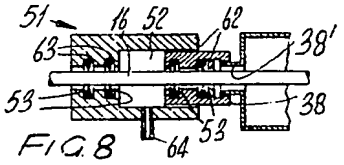

FIG. 8

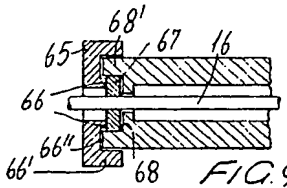

FIG. 9

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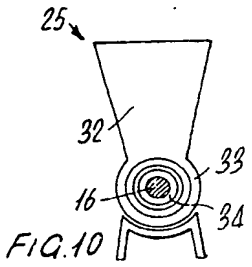

FIG.10